THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DIVISION OF OCCUPATIONAL SAFETY
OCCUPATIONAL HYGIENE / INDOOR AIR QUALITY PROGRAM
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Mechanical Ventilation Systems and Air Quality: Discussion and Suggestions

The purpose of mechanical ventilation systems is to provide conditioned (tempered and filtered, mixed fresh and re-circulated) air to all occupied spaces. Where there is inadequate fresh air ventilation for the number of persons present or for the activities performed, perceived air quality can deteriorate as the day progresses.

Requirements for ventilation system design are set by the edition of the Massachusetts State Building Code in effect at the time of construction (see attached information). Code requirements have varied over the years. These codes do not insure continuing good air quality rather they describe the type of ventilation system that was to be installed at the time of construction. Once installed, ventilation problems may occur when systems are not properly maintained or operated, or when building usage changes. The Massachusetts Occupational Hygiene Program, as a result of doing hundreds of indoor air quality investigations, and a review of current and past ventilation codes, provides the following suggestions for fresh ventilation system operation, to provide for the health and comfort of employees working in schools and offices.

Percentage of Fresh Outside Air	**Fresh Outside Air Rate CFM per Occupant**	**Air Changes per Hour**
Minimum of 15%, but 25% is preferred	**Minimum of 20 is preferred where no smoking is permitted**[1]	**Minimum of 6, but ten is preferred**

1. Minimum of 35 cfm per occupant where smoking is permitted. Alternatively, a separate smoking lounge should have 60 cfm per smoker exhausted to the outside air without any re-circulation of room air. Tempered make-up air may be needed.

The total airflow supplied to a space is made up of re-circulated air and outside air. Airflow rates are measured in cubic feet per minute (CFM). The Percentage of Fresh Outside Air is that portion that is taken directly from out-of-doors. With high occupancy rates, the amount of outside air should be based on the number of occupants times the Fresh Outside Air Rate. Air changes Per Hour are based on the total air flow rate supplied to the space and the volume of the space. Higher air change rates tend to increase the effectiveness of the ventilation to reach all areas of the ventilated space.

Ventilation system fans should run continuously during all periods of occupancy (e.g.: thermostat fan switches should be in the "on" rather than the "auto" position). Fans should continue to run during off-hours cleaning activities. Turning fans on an hour or two prior to occupancy can improve air quality.

The dust filtration capability of ventilation systems can have a major impact on indoor air quality. Also important is proper maintenance of ventilation systems. For more information on these topics see this agency's HVAC and Building Maintenance bulletin.

The effectiveness of ventilation systems can be reduced significantly at room level by blocking supply or return vents. Subdividing rooms or installing tall partitions (over 54 inches) can cause local pockets of stale air. Local ventilation units that are turned off due to noise need repair or maintenance.

Temperature control and relative humidity are important aspects of perceived air quality. Temperatures outside normal ranges can affect general comfort, and may influence ability to concentrate. Air that is heated will generally be lower in humidity (dryer) than outside air. Relative humidity below 30% can contribute to eye and respiratory symptoms. High humidity or water leaks can lead to mold problems. For more information see this agency's Thermal Comfort Guidelines and Water Damaged Materials bulletins.

It is important to note that not all indoor air quality concerns can be attributed solely to inadequate mechanical ventilation and/or temperature and humidity, specific pollutant sources may exist affecting air quality throughout a space or only in a localized area. Keeping track of where and when air quality deteriorates can help identify pollutant sources or other factors that affect indoor air quality.

Ventilation Codes in Massachusetts

The ventilation originally designed and installed for each building in Massachusetts varies according to the original use of the building and to the date of building permit approval by local authorities. Other than local zoning requirements, regulation of building design and construction (by local and state building officials) is based on **780 CMR: The Massachusetts State Building Code**. New codes are issued on a periodic basis by the State Board of Building Regulations and Standards. Usually when new editions of the State Building code are issued, there is an overlap period (six months to a year) during which local building officials can pick which edition they are enforcing. State requirements and referenced standards in the State Building Code have varied over the years. Extensive remodeling (depending on year, 50% of value or floor space) or the replacement of the ventilation system would mean codes of that year apply. Relevant ventilation requirements of the different codes for certain types of occupied areas are listed on an attached table.

Enforcement of the State Building Code rests primarily with local building officials **(780 CMR 106.0 Duties and Powers of the Building Official)**. For any structures or buildings that are owned by the Commonwealth or any departments, commissions, agencies, or authorities of the Commonwealth, 780 CMR is enforced by the State Inspector of the Department of Public Safety, Division of Inspections **(780 CMR 107.0 Duties and Powers of the State Inspector)**.

Prior to January 1, 1975, there was no comprehensive, uniform state building code in Massachusetts. Ventilation design requirements varied according to any existing local codes or designers professionalism. Reference may or may not have been made to ASHRAE or BOCA Standards or to ASA Standard A53.1 (May 23, 1946). The reference for school buildings was most commonly the Board of Schoolhouse Structural and Ventilation Standards, Form B-2, which had been in effect since the 1940's. The Department of Public Safety adopted this standard in August 1972.

January 1, 1975 to December 31, 1979. The first two editions of the Uniform State Building Code were issued in this time period. Both referenced the same ventilation standards: the Board of Schoolhouse Structural and Ventilation Standards, Form B-2 for schools and ASHRAE Standard 62-73 for Natural and Mechanical Ventilation for most other buildings.

January 1, 1979 to December 31, 1979. Communities could choose to enforce either the Second or Third Edition of the State Building code. The Third Edition referenced the 1978 BOCA Mechanical Ventilation Code for all buildings.

January 1, 1980 to July 1, 1988. The Third Edition of State Building Code was in effect. It referenced the 1978 BOCA Code.

July 1, 1988. Fourth Edition of State Building Code. Referenced: 1987 BOCA Code. **A Special Ventilation Provision in the State Building Code dated 6/12/87 requires that the minimum amount of fresh outdoor air for schools and office buildings shall be not less than 10 cfm per person.**

September 1990. Fifth Edition of State Building Code. Referenced: 1987 BOCA Code.

February 1997. Sixth Edition. Referenced: 1993 BOCA Code. Access to attics and crawl spaces, if separating conditioned from unconditioned spaces, shall be weather-stripped and close tightly. **Section 3400.6 For existing buildings, where the light or ventilation do not meet state code and which, in the opinion of the building official are dangerous or hazardous to the health and safety of the occupants, the local building official shall order abatement. The building official can require or accept engineering or other evaluations in order to evaluate possible dangerous or hazardous conditions and acceptable solutions.**

Definitions and Sources:

ASHRAE:	American Society of Heating, Refrigeration, and Air-conditioning Engineers
BOCA:	Building Officials & Code Administrators International, Inc.
ASA:	American Society of Architects